

PIC16(L)F1824/1828 Family Silicon Errata and Data Sheet Clarification

The PIC16(L)F1824/1828 family devices that you have received conform functionally to the current Device Data Sheet (DS40001419E), except for the anomalies described in this document.

The silicon issues discussed in the following pages are for silicon revisions with the Device and Revision IDs listed in [Table 1](#). The silicon issues are summarized in [Table 2](#).


The errata described in this document will be addressed in future revisions of the PIC16(L)F1824/1828 silicon.

Note: This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current. Only the issues indicated in the last column of [Table 2](#) apply to the current silicon revision (**A5**).

Data Sheet clarifications and corrections start on page 12, following the discussion of silicon issues.

The silicon revision level can be identified using the current version of MPLAB® IDE and Microchip's programmers, debuggers, and emulation tools, which are available at the Microchip corporate web site (www.microchip.com).

For example, to identify the silicon revision level using MPLAB IDE in conjunction with a hardware debugger:

1. Using the appropriate interface, connect the device to the hardware debugger.
2. Open an MPLAB IDE project.
3. Configure the MPLAB IDE project for the appropriate device and hardware debugger.
4. Based on the version of MPLAB IDE you are using, do one of the following:
 - a) For MPLAB IDE 8, select *Programmer > Reconnect*.
 - b) For MPLAB X IDE, select *Window > Dashboard* and click the **Refresh Debug Tool Status** icon ().
5. Depending on the development tool used, the part number *and* Device Revision ID value appear in the **Output** window.

Note: If you are unable to extract the silicon revision level, please contact your local Microchip sales office for assistance.

The DEVREV values for the various PIC16(L)F1824/1828 silicon revisions are shown in [Table 1](#).

TABLE 1: SILICON DEVREV VALUES

Part Number	DEVICE ID<13:0> ^{(1), (2)}				
	DEV<8:0>	Revision ID for Silicon Revision			
		A1	A3	A4	A5
PIC16F1824	10 0111 010	0 0001	0 0011	0 0100	0 0101
PIC16LF1824	10 1000 010	0 0001	0 0011	0 0100	0 0101
PIC16F1828	10 0111 110	0 0001	0 0011	0 0100	0 0101
PIC16LF1828	10 1000 110	0 0001	0 0011	0 0100	0 0101

- Note 1:** The Device ID is located in the configuration memory at address 8006h.
- 2:** Refer to the “*PIC12(L)F1822/PIC16(L)F182X Memory Programming Specification*” (DS41390) for detailed information on Device and Revision IDs for your specific device.

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TABLE 2: SILICON ISSUE SUMMARY

Module	Feature	Item Number	Issue Summary	Affected Revisions ⁽¹⁾			
				A1	A3	A4	A5
ADC	ADC Conversion	1.1	ADC Conversion may not complete.	X			
Oscillator	HS Oscillator	2.1	HS Oscillator min. VDD.	X			
Oscillator	Clock Switching	2.2	Clock switching can cause a single corrupted instruction.	X	X		
Oscillator	Oscillator Start-up Timer	2.3	OSTS bit remains set.	X	X	X	
Enhanced Capture Compare PWM (ECCP)	Enhanced PWM	3.1	PWM 0% duty cycle direction change.	X			
Enhanced Capture Compare PWM (ECCP)	Enhanced PWM	3.2	PWM 0% duty cycle port steering.	X			
Enhanced Capture Compare PWM (ECCP)	Capture Mode	3.3	TTL Input selection suppresses capture event (PIC16(L)F1828 devices only)	X	X	X	X
Timer1	T1 Gate Toggle mode	4.1	T1 Gate flip-flop does not clear.	X			
In-Circuit Serial Programming™ (ICSP™)	Low-Voltage Programming	5.1	Bulk Erase not available with LVP.	X			
Clock Switching	OSTS Status Bit	6.1	Remains clear when 4xPLL enabled.	X	X	X	X
BOR	Wake-up from Sleep	7.1	Device resets on wake-up from Sleep (LF devices only).	X	X		
Enhanced Universal Synchronous Asynchronous Receiver (EUSART)	16-Bit High-Speed Asynchronous mode	8.1	Works improperly at maximum rate.	X	X	X	X
Enhanced Universal Synchronous Asynchronous Receiver (EUSART)	Auto-Baud Detect	8.2	Auto-Baud Detect may store incorrect count value in the SPBRG registers.	X	X		
PFM Self-Writes	PFM Self-Write	9.1	PFM Self-Write will not work depending on clock selection.			X	
MSSP (Master Synchronous Serial Port)	SPI Master mode	10.1	Buffer Full (BF) bit or MSSP Interrupt Flag (SSPIF) bit becomes set half SCK cycle too early.	X	X	X	X

Note 1: Only those issues indicated in the last column apply to the current silicon revision.

Silicon Errata Issues

Note: This document summarizes all silicon errata issues from all revisions of silicon, previous as well as current. Only the issues indicated by the shaded column in the following tables apply to the current silicon revision (A5).

1. Module: ADC

1.1 Analog-to-Digital Conversion

An ADC conversion may not complete under these conditions:

1. When FOSC is greater than 8 MHz and it is the clock source used for the ADC converter.
2. The ADC is operating from its dedicated internal FRC oscillator and the device is not in Sleep mode (any FOSC frequency).

When this occurs, the ADC Interrupt Flag (ADIF) does not get set, the GO/DONE bit does not get cleared, and the conversion result does not get loaded into the ADRESH and ADRESL result registers.

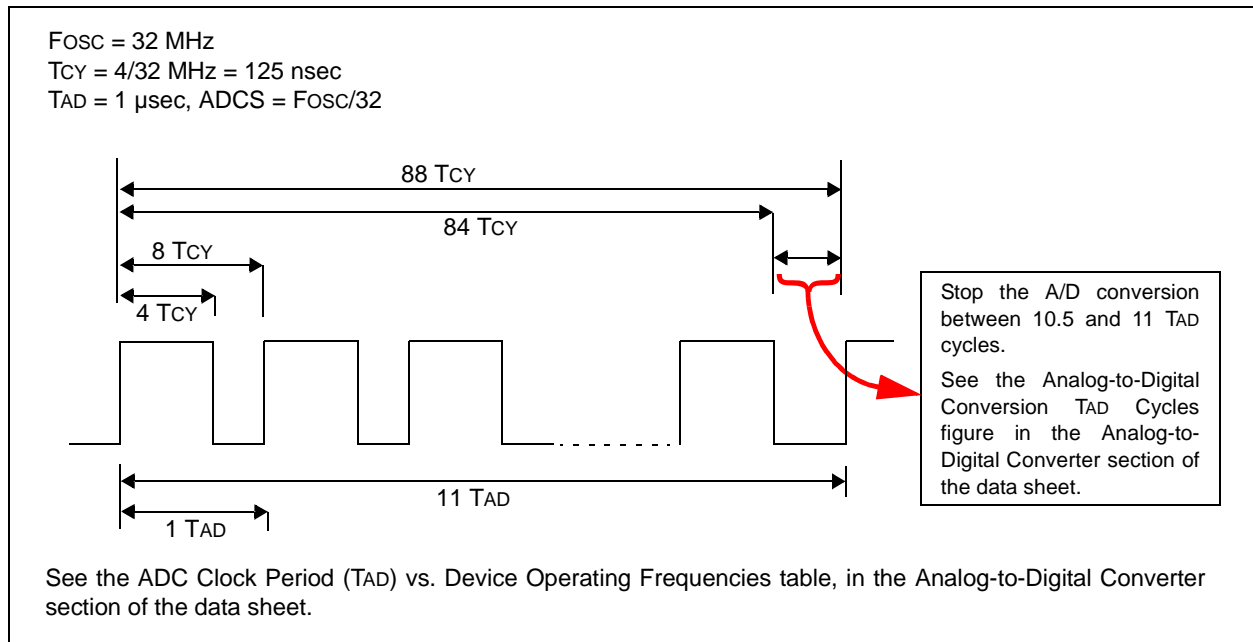
Work around

Method 1: Select the system clock, FOSC, as the ADC clock source and reduce the FOSC frequency to 8 MHz or less when performing ADC conversions.

Method 2: Select the dedicated FRC oscillator as the ADC conversion clock source and perform all conversions with the device in Sleep.

Method 3: This method is provided if the application cannot use Sleep mode and requires continuous operation at frequencies above 8 MHz. This method requires early termination of an ADC conversion. Provide a fixed time delay in software to stop the A-to-D conversion manually, after all 10 bits are converted, but before the conversion would complete automatically. The conversion is stopped by clearing the GO/DONE bit in software. The GO/DONE bit must be cleared during the last 1/2 TAD cycle, before the conversion would have completed automatically. Refer to Figure 1 for details.

FIGURE 1: INSTRUCTION CYCLE DELAY CALCULATION EXAMPLE



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In Figure 1, 88 instruction cycles (Tcy) will be required to complete the full conversion. Each TAD cycle consists of 8 Tcy periods. A fixed delay is provided to stop the A/D conversion after 86 instruction cycles and terminate the conversion at the correct time as shown in the figure above.

Note: The exact delay time will depend on the TAD divisor (ADCS) selection. The Tcy counts shown in the timing diagram above apply to this example only. Refer to Table 3 for the required delay counts for other configurations.

EXAMPLE 1: CODE EXAMPLE OF INSTRUCTION CYCLE DELAY

```
BSF    ADCON0, ADGO    ; Start ADC conversion
                        ; Provide 86
                        ; instruction cycle
                        ; delay here
BCF    ADCON0, ADGO    ; Terminate the
                        ; conversion manually
MOVF   ADRESH, W       ; Read conversion
                        ; result
```

For other combinations of FOSC, TAD values and Instruction cycle delay counts, refer to Table 3.

TABLE 3: INSTRUCTION CYCLE DELAY COUNTS BY TAD SELECTION

TAD	Instruction Cycle Delay Counts
Fosc/64	172
Fosc/32	86
Fosc/16	43

Affected Silicon Revisions

A1	A3	A4	A5				
X							

2. Module: Oscillator

2.1 HS Oscillator

The HS oscillator requires a minimum voltage of 3.0 volts (at 65°C or less) to operate at 20 MHz.

Work around

None.

Affected Silicon Revisions

A1	A3	A4	A5				
X							

2.2 Clock Switching

When switching clock sources between INTOSC clock source and an external clock source, one corrupted instruction may be executed after the switch occurs.

This issue does not affect Two-Speed Start-up or the Fail-Safe Clock Monitor operation.

Work around

When switching from an external oscillator clock source, first switch to 16 MHz HFINTOSC. Once running at 16 MHz HFINTOSC, configure IRCF to run at desired internal oscillator frequency.

When switching from an internal oscillator (INTOSC) to an external oscillator clock source, first switch to HFINTOSC High-Power mode (8 MHz or 16 MHz). Once running from HFINTOSC, switch to the external oscillator clock source.

Affected Silicon Revisions

A1	A3	A4	A5				
X	X						

2.3 Oscillator Start-up Timer

During the Two-Speed Start-up sequence, the Oscillator Start-up Timer is enabled to count 1024 clock cycles. After the count is reached, the OSTS bit is set, the system clock is held low until the next falling edge of the external crystal (LP, XT or HS mode), before switching to the external clock source.

When an external oscillator is configured as the primary clock and Fail-Safe Clock mode is enabled (FCMEN = 1), any of the following conditions will result in the Oscillator Start-up Timer failing to restart:

- MCLR Reset
- Wake from Sleep
- Clock change from INTOSC to Primary Clock

This anomaly will manifest itself as a clock failure condition for external oscillators which take longer than the clock failure time-out period to start.

Work around

None.

Affected Silicon Revisions

A1	A3	A4	A5				
X	X	X					

3. Module: Enhanced Capture Compare PWM (ECCP)

3.1 Enhanced PWM

When the PWM is configured for Full-Bridge mode and the duty cycle is set to 0%, writing the Pxm<1:0> bits to change the direction has no effect on PxA and PxC outputs.

Work around

Increase the duty cycle to a value greater than 0% before changing directions.

Affected Silicon Revisions

A1	A3	A4	A5				
X							

3.2 Enhanced PWM

In PWM mode, when the duty cycle is set to 0% and the STRxSYNC bit is set, writing the STRxA, STRxB, STRxC and the STRxD bits to enable/disable steering to port pins has no effect on the outputs.

Work around

Increase the duty cycle to a value greater than 0% before enabling/disabling steering to port pins.

Affected Silicon Revisions

A1	A3	A4	A5				
X							

3.3. Capture Mode

This issue applies to the PIC16(L)F1828 devices only.

When the input threshold control for RC6 is configured for TTL, the CCP4 capture input is ignored.

Note: All CCP Capture pins function at Schmitt Trigger logic levels. The INVLx registers apply only to PORT reads and Interrupt-on-Change.

Work around

Use the Schmitt Trigger threshold level by setting the INVLC <6> bit.

Affected Silicon Revisions

A1	A3	A4	A5				
X	X	X	X				

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4. Module: Timer1

4.1 Timer1 Gate Toggle mode

When Timer1 Gate Toggle mode is enabled, it is possible to measure the full-cycle length of a Timer1 gate signal. To perform this function, the Timer1 gate source is routed through a flip-flop that changes state on every incrementing edge of the gate signal. Timer1 Gate Toggle mode is enabled by setting the T1GTM bit of the T1GCON register. When working properly, clearing either the T1GTM bit or the TMR1ON bit would also clear the output value of this flip-flop, and hold it clear. This is done in order to control which edge is being measured. The issue that exists is that clearing the TMR1ON bit does not clear the output value of the flip-flop and hold it clear.

Work around

Clear the T1GTM bit in the T1GCON register to clear and hold clear the output value of the flip-flop.

Affected Silicon Revisions

A1	A3	A4	A5				
X							

5. Module: In-Circuit Serial Programming™ (ICSP™)

5.1 Bulk Erase Feature not available with Low-Voltage Programming mode

A bulk erase of the program Flash memory or data memory cannot be executed in Low-Voltage Programming mode.

Work around

Method 1: If ICSP Low-Voltage Programming mode is required, use row erases to erase the program memory, as described in the Program/Verify mode section of the Programming Specification. Data memory must be over-written with the desired values.

Method 2: Use ICSP High-Voltage Programming mode if a bulk erase is required.

Note: Only the bulk erase feature will erase program or data memory if code or data protection is enabled. Method 2 must be used if code or data protection is enabled.

Affected Silicon Revisions

A1	A3	A4	A5				
X							

6. Module: Clock Switching

6.1 OSTS Status Bit

When the 4xPLL is enabled, the Oscillator Start-up Time-out Status (OSTS) bit always remains clear.

Work around

None.

Affected Silicon Revisions

A1	A3	A4	A5				
X	X	X	X				

7. Module: BOR

7.1 BOR Reset

This issue affects only the PIC16LF1824/1828 devices. The device may undergo a BOR Reset when waking-up from Sleep and BOR is re-enabled. A BOR Reset may also occur the moment the software BOR is enabled.

Under certain voltage and temperature conditions and when either SBODEN or BOR_NSLEEP is selected, the devices may occasionally reset when waking-up from Sleep or BOR is enabled.

Work around

- Method 1: In applications where BOR use is not critical, turn off the BOR in the Configuration Word.
- Method 2: Set the FVREN bit of the FVRCON register. Maintain this bit on at all times.
- Method 3: When BOR module is needed only during run-time, use the software-enabled BOR by setting the SBODEN option on the Configuration Word. BOR should be turned off by software before Sleep, then follow the below sequence for turning BOR on after wake-up:
- Wake-up event occurs;
 - Turn on FVR (FVREN bit of the FVRCON register);
 - Wait until FVRRDY bit is set;
 - Wait 15 μ s after the FVR Ready bit is set;
 - Manually turn on the BOR.
- Method 4: Use the software-enabled BOR as described in Method 3, but use the following sequence:
- Switch to internal 32 kHz oscillator immediately before Sleep;
 - Upon wake-up, turn on FVR (FVREN bit of the FVRCON register);
 - Manually turn on the BOR;
 - Switch the clock back to the preferred clock source.

Note: When using the software BOR follow the steps in Methods 3 or 4 above when enabling BOR for the first time during program execution.

Affected Silicon Revisions

A1	A3	A4	A5				
X	X						

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8. Module: Enhanced Universal Synchronous Asynchronous Receiver (EUSART)

8.1 16-Bit High-Speed Asynchronous Mode

The EUSART provides unexpected operation when the 16-Bit High-Speed Asynchronous mode is selected and the Baud Rate Generator Data register values are loaded with zero (0). We do not recommend using this configuration for EUSART communication. The configuration is shown below in the following table:

Configuration Bits			BRG Data Registers	
SYNC	BRG16	BRGH	SPBRGH Value	SPBRGL Value
0	1	1	00000000	00000000

Work around

Ensure that the SPBRGH or the SPBRGL register is loaded with a non-zero value.

Affected Silicon Revisions

A1	A3	A4	A5				
X	X	X	X				

8.2 Auto-Baud Detect

When using automatic baud detection (ABDEN), on occasion, an incorrect count value can be stored at the end of auto-baud detection in the SPBRGH:SPBRGL (SPBRG) registers. The SPBRG value may be off by several counts. This condition happens sporadically when the device clock frequency drifts to a frequency where the SPBRG value oscillates between two different values. The issue is present regardless of the baud rate Configuration bit settings.

Work around

When using auto-baud, it is a good practice to always verify the obtained value of SPBRG, to ensure it remains within the application specifications. Two recommended methods are shown below.

For additional auto-baud information, see Technical Brief TB3069, "Use of Auto-Baud for Reception of LIN Serial Communications Devices: Mid-Range and Enhanced Mid-Range".

EXAMPLE 2: METHOD 1 – EUSART AUTO-BAUD DETECT WORK AROUND

In firmware, define default, minimum and maximum auto-baud (SPBRG) values according to the application requirements.

For example, if the application runs at 9600 baud at 16 MHz then, the default SPBRG value would be (assuming 16-bit/Asynchronous mode) 0x67. The minimum and maximum allowed values can be calculated based on the application. In this example, a +/-5% tolerance is required, so tolerance is $0x67 * 5\% = 0x05$.

```
#define SPBRG_16BIT    *((*int)&SPBRG;                // define location for 16-bit SPBRG value

const int DEFAULT_BAUD = 0x0067;                    // Default Auto-Baud value
const int TOL = 0x05;                               // Baud Rate % tolerance
const int MIN_BAUD = DEFAULT_BAUD - TOL;           // Minimum Auto-Baud Limit
const int MAX_BAUD = DEFAULT_BAUD + TOL;           // Maximum Auto-Baud Limit
    .
    .
    .
ABDEN = 1;                                           // Start Auto-Baud
while (ABDEN);                                       // Wait until Auto-Baud completes

if((SPBRG_16BIT > MAX_BAUD)|| (SPBRG_16BIT < MIN_BAUD))
{
    SPBRG_16BIT = DEFAULT_BAUD;                     // Compare if value is within limits
                                                    // if out of spec, use DEFAULT_BAUD
}
    .
    .
    .
                                                    // if in spec, continue using the
                                                    // Auto-Baud value in SPBRG
```

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EXAMPLE 3: METHOD 2 – EUSART AUTO-BAUD DETECT WORK AROUND

Similar to Method 1, define default, minimum and maximum auto-baud (SPBRG) values. In firmware, compute a running average of SPBRG. If the new SPBRG value falls outside the minimum or maximum limits, then use the current running average value (Average_Baud), otherwise use the auto-baud SPBRG value and calculate a new running average.

For example, if the application runs at 9600 baud at 16 MHz then, the default SPBRG value would be (assuming 16-bit/Asynchronous mode) 0x67. The minimum and maximum allowed values can be calculated based on the application. In this example, a +/-5% tolerance is required, so tolerance is $0x67 * 5\% = 0x05$.

```
#define SPBRG_16BIT    *((*int)&SPBRG;                // define location for 16-bit SPBRG value

const int DEFAULT_BAUD = 0x0067;                    // Default Auto-Baud value
const int TOL = 0x05;                               // Baud Rate % tolerance
const int MIN_BAUD = DEFAULT_BAUD - TOL;           // Minimum Auto-Baud Limit
const int MAX_BAUD = DEFAULT_BAUD + TOL;           // Maximum Auto-Baud Limit

int Average_Baud;                                    // Define Average_Baud variable
int Integrator;                                      // Define Integrator variable
.
.
.
Average_Baud = DEFAULT_BAUD;                        // Set initial average Baud rate
Integrator = DEFAULT_BAUD*15;                       // The running 16 count average
.
.
.
ABDEN = 1;                                          // Start Auto-Baud
while (ABDEN);                                     // Wait until Auto-Baud completes

Integrator+ = SPBRG_16BIT;
Average_Baud = Integrator/16;
if((SPBRG_16BIT > MAX_BAUD)|| (SPBRG_16BIT < MIN_BAUD))
{
    SPBRG_16BIT = Average_Baud;                    // If out of spec, use previous average
}
else
{
    Integrator+ = SPBRG_16BIT;                     // If in spec, calculate the running
    Average_Baud = Integrator/16;                  // average but continue using the
    Integrator- = Average_Baud;                    // Auto-Baud value in SPBRG
}
.
.
.
```

Affected Silicon Revisions

A1	A3	A4	A5				
X	X						

9. Module: PFM Self-Writes

9.1 PFM

Writes to the PFM will not execute if the device's clock source is HS, ECH, or the Internal Oscillator is at either 8 MHz or 16 MHz. The DFM is unaffected.

Work around

To write to the PFM, the clock source must be one of the following settings: Internal Oscillator set to 4 MHz or lower, ECM, ECL, XT, External RC, LP or T1OSC.

Affected Silicon Revisions

A1	A3	A4	A5				
		X					

10. Module: MSSP (Master Synchronous Serial Port)

10.1 SPI Master mode

When the MSSP is used in SPI Master mode and the CKE bit is clear (CKE = 0), the Buffer Full (BF) bit and the MSSP Interrupt Flag (SSPIF) bit becomes set half an SCK cycle early. If the user software immediately reacts to either of the bits being set, a write collision may occur as indicated by the WCOL bit being set.

Work around

To avoid a write collision one of the following methods should be used:

Method 1: Add a software delay of one SCK period after detecting the completed transfer (the BF bit or SSPIF bit becomes set) and prior to writing to the SSPBUF register. Verify the WCOL bit is clear after writing to SSPBUF. If the WCOL bit is set, clear the bit in software and rewrite the SSPBUF register.

Method 2: As part of the MSSP initialization procedure, set the CKE bit (CKE = 1).

Affected Silicon Revisions

A1	A3	A4	A5				
X	X	X	X				

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Data Sheet Clarifications

The following typographic corrections and clarifications are to be noted for the latest version of the device data sheet (DS40001419E):

<p>Note: Corrections are shown in bold. Where possible, the original bold text formatting has been removed for clarity.</p>

None.

APPENDIX A: DOCUMENT REVISION HISTORY

Rev A Document (06/2010)

Initial release of this document.

Rev B Document (07/2010)

Revised Module 1.1; Added Module 6.1; Other minor corrections.

Rev C Document (12/2010)

Updated errata to new format; Added Revision A3; Added Module 7.

Rev D Document (09/2011)

Added Module 8, BOR.

Rev E Document (02/2012)

Updated Table 1; Added Modules 2.2, 2.3 and 2.4; Added Module 9, EUSART; Other minor corrections.

Data Sheet Clarifications: Added Module 1, Oscillator.

Rev F Document (04/2012)

Added Silicon Revision A4.

Rev G Document (08/2012)

Added Module 9.1

Rev H Document (12/2012)

Removed Module 5.1 ADC (Error Parameters).

Added Silicon Revision A5.

Rev J Document (01/2014)

Added Module 3.3; Other minor corrections.

Rev K Document (12/2014)

Added Module 10, MSSP; Other minor corrections.

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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ISBN: 978-1-63276-776-9

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China - Xiamen
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China - Zhuhai
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Fax: 91-80-3090-4123

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India - Pune
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Japan - Osaka
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Japan - Tokyo
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Korea - Daegu
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Fax: 82-53-744-4302

Korea - Seoul
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Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
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Malaysia - Penang
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Philippines - Manila
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Fax: 63-2-634-9069

Singapore
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Taiwan - Hsin Chu
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Taiwan - Kaohsiung
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Fax: 34-91-708-08-91

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03/25/14